

C-14 releases from the Fukushima Dai-ichi Nuclear Power Plant

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C-14 is one of the most important radionuclides for regional radiological assessment because it gives a significant fraction of the effective dose to the general public through the atmosphere-food-ingestion pathway. After Fukushima Dai-ichi Nuclear Power Plant (FDNPP) accident on 11th March 2011, significant quantities of radioactive substances were released into the atmosphere, causing serious radioactive contamination in eastern Japan. Numerous measurements of Fukushima-derived radionuclides, mainly short-lived nuclides such as ^{134,137}Cs and ¹³¹I, in the local and worldwide environment have been reported. However, long-lived nuclides, in particular ¹⁴C (half-life 5730 y), are less paid attention.

In this study, the ¹⁴C activities were measured in annual tree rings for the years 1971 to 2015 from Japanese cedar trees (*Cryptomeria japonica*) collected at seven sites ranging from 1–38 km of the FDNPP. In comparison with the background level, the elevated ¹⁴C activities observed in the 1976 and 2010 rings indicate the occurrence of ¹⁴C discharges during routine reactor operations, whereas those activities that were indistinguishable from background in 2012–2015 coincided with the permanent shutdown of the reactors after the accident. High-resolution ¹⁴C analysis of the 2011 ring indicated that the excess ¹⁴C was released from the damaged reactors units 1-4 during the accident and that the ¹⁴C specific activity decreased with increasing distance from the FDNPP, along the main northwest wind direction. Our findings indicate that the ¹⁴C released during the accident and normal operations is indistinguishable from background beyond the local environment (probably ~20 km from the FDNPP). Furthermore, the estimated additional dose to the local population from the excess ¹⁴C activities due to releases during the routine operations and the accident is negligible compared to the dose from natural/nuclear weapons sources.